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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference RS/pe-16075	**FOR FURTHER ACTION** See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/CH 03/00246	International filing date *(day/month/year)* 11.04.2003	Priority date *(day/month/year)* 12.04.2002
International Patent Classification (IPC) or both national classification and IPC H01F27/28		
Applicant DELTA ENERGY SYSTEMS AG		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10.11.2003	09.07.2004
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Durville, G Telephone No. +31 70 340-2961

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CH 03/00246

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-10 as originally filed

Claims, Numbers

1-31 received on 12.05.2004 with letter of 12.05.2004

Drawings, Sheets

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☒ the claims, Nos.: 32,33
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-31
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-31
Industrial applicability (IA)	Yes:	Claims	1-31
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1: WO 00 11687 A (ALLISON HERMAN ;FRICKER RONALD KEVIN (ZA); SMIT MARTHINUS CHRISTOF) 2 March 2000 (2000-03-02)

D2: US 2001/020886 A1 (NAGAI JUN ET AL) 13 September 2001 (2001-09-13)

D3: US-A-6 069 548 (BAARMAN GOESTA ET AL) 30 May 2000 (2000-05-30)

2 Independent claims 1 and 14 do not meet the requirements of the PCT in respect of inventive step, the reasons being as follows:
Document D1, which is considered to represent the most relevant state of the art, discloses (cf. fig. 1-13; page 3, lines 14-18 and claims 1 and 11) all the features or method steps of claims 1 and 14 except for the feature that the core forms a single unbranched and closed flux path. The problem to be solved by the present invention may therefore be regarded as reducing the size of the transformer. The solution proposed in the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons: it is generally known to the person skilled in the art that the feature of a single unbranched and closed flux path is an equivalent to the feature of an E core and can be interchanged with that feature where circumstances make it desirable.

3 Independent claims 13, 21 and 31 do not meet the requirements of the PCT in respect of inventive step, the reasons being as follows:
As far as claims 13 and 31 are concerned, document D2, which is considered to represent the most relevant state of the art, discloses (cf. fig. 6 and claim 1) all the features of claims 13 and 31 except for the multilayer circuit element. On the other hand, D1 discloses all the features of claim 21, again except for multilayer circuit element. The problem to be solved by the present invention may therefore be regarded as reducing the size of the transformer. The solution proposed in the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons. This feature is described in document D3 (cf. col. 1, lines 39-45) as providing the same advantages as in the present application. The skilled person would therefore regard it as a normal design option to include this feature in the transformer described in document D2 (for claims 13

and 31) or D1 (for claim 21) in order to solve the problem posed. Again, it is generally known to the person skilled in the art that the feature of a single unbranched and closed flux path is an equivalent to the feature of an E core and can be interchanged with that feature where circumstances make it desirable.

4 Claims 2-12, 15-20 and 22-30 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:
- D1 discloses a planar transformer and further discloses all additional features set out in claims 10, 11 and 19, so that the subject-matter of claims 10, 11 and 19 does not involve an inventive step.
- D3 discloses a planar transformer and further discloses all additional features set out in claims 2, 3 and 4, so that the subject-matter of claims 2, 3 and 4 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT in light of the combination of documents D1 and D3.
- In claims 5-8, 9, 12, 15-18, 20 and 22-30, a slight constructional change is defined which comes within the scope of the customary practice followed by persons skilled in the art.

5 Claims 1 to 31 relate to a transformer and are therefore susceptible of industrial applicability (A.33(4)PCT).

We claim:

1. A magnetic circuit element including a circuit board, at least two flux-conducting magnetic core arms penetrating the board, at least two flux-conducting magnetic core elements extending between the magnet core arms, one on each side of the circuit board, at least two series-connected primary windings on the board in at least partially encircling relation to at least one of the arms and at least two parallel-connected secondary windings on the board in at least partially encircling relation to at least one of the arms wherein the core arms and core elements form a single, unbranched, closed flux path, whereby all of the primary and secondary windings are linked by the same flux.

2. The magnetic circuit element according to claim 1, wherein the circuit board is a multilayer circuit board and at least one of the windings is a buried winding located between layers of the multilayer circuit board.

3. The magnetic circuit element according to claim 2, wherein each of the windings is a buried winding located between layers of the multilayer circuit board.

4. The magnetic circuit element according to claim 2, further comprising circuit component, including one or more power components, occupying at least one outer surface of the circuit board above or below the at least one buried winding.

5. The magnetic circuit element according to claim 1, wherein each of the primary windings has substantially the same number of turns as each other secondary winding.

6. The magnetic circuit element according to claim 5, wherein each of the secondary windings has substantially the same number of turns as each other secondary winding.

7. The magnetic circuit element according to claim 1, wherein the number of primary windings is the same as the number of secondary windings, each primary winding being wound in closely coupled relation to a secondary winding.

8. The magnetic circuit element according to claim 6, wherein the number of primary windings is the same as the number of secondary windings, each primary winding being wound in closely coupled relation to a secondary winding.

9. The magnetic circuit element according to claim 2, wherein all of the core arms and core elements are selected from the group consisting of C and I elements.

10. The magnetic circuit element according to claim 1, having an even number of core arms in excess of two.

11. The magnetic circuit element according to claim 10, having in excess of two magnetic core arms penetrating the board, each core arm being wound with at least one of the primary and secondary windings.

12. The magnetic circuit element according to claim 11, wherein each core arm is wound with at least one of the primary windings and at least one of the secondary windings.

13. A multilayer printed circuit board of the kind having first and second surfaces on first and second sides of the board and including a transformer with windings defined between layers of the board and a transformer core penetrating the layers of the board and about which the windings are wound; the improvement comprising; a plurality of at least four magnetic core segments extending through the board from the first side to the second side at spaced apart locations;

a) said windings comprising a plurality of at least four windings, each at least partially encircling a separate one of the core segments where the core segments extend through the board;

b) a plurality of substantially planar first magnetic core elements at the first side of the board, each of the first core elements extending between a pair of the magnetic core segments in flux-conducting relation thereto such that each core segment at the first side of the board is joined in flux-

conducting relation to another of the core segments by one of the substantial planar core elements at the first side of the board; and

c) a plurality of substantially planar second magnetic core elements at the second side of the board, each of the second magnetic core elements at the second side of the board extending between a pair of the magnetic core segments in flux-conducting relation thereto, each pair of core segments between which a second magnetic core element extends at the second side of the board being in a separate pair of the core segments joined in flux-conducting relation by first magnetic core elements at the first side of the board;

the magnetic core elements and core segments forming an unbranched, closed magnetic flux path extending across the first and second faces and through the layers of the board.

14. A method of power conversion for providing high amperage, low voltage power including:

(a) providing a printed circuit board,

(b) forming holes through the printed circuit board,

(c) locating magnetic core arms in the holes formed in the printed circuit board,

(d) locating magnetic core elements in flux-conducting relation between the core arms on opposite faces of the printed circuit board to form a transformer core that has a single, unbranched,closed flux path,

(e) winding a plurality of series-connected windings, on the core arms to form a transformer primary,

(f) winding a plurality of parallel-connected windings, on the core arms to form a transformer secondary.

15. The method according to claim 14, further comprising providing a plurality of output treating circuits at the output of each of the windings forming the secondary, the output heating circuits being connected between these windings and a current additive point of connection of the windings.

16. The method according to claim 14, wherein the steps of winding the series-connected windings and winding the parallel-connected windings comprises winding at least one of the series-connected windings in closely coupled relation to one of the parallel-connected windings on each of the core arms.

17. The method according to claim 16, wherein forming holes in the printed circuit board comprises forming in excess of two holes therein, and the step of locating magnetic core arms in the holes comprises locating in excess of two core arms, winding a plurality of series-connected windings comprises winding in excess of two series-connected windings on the core arms, and winding a plurality of parallel-connected windings comprises winding in excess of two parallel-connected windings on the core arms.

18. The method according to claim 17, wherein each step of winding comprises printing or depositing a winding on a surface of the printed circuit board in at least partially encircling relation to one of the core arms.

19. The method according to claim 14, wherein each step of winding comprises printing or depositing a winding on a surface of the printed circuit board in at least partially encircling relation to one of the core arms.

20. The method according to claim 14, wherein the step of providing a printed circuit board comprises providing a multilayer circuit board, and the steps of winding a plurality of series-connected and parallel-connected windings comprise providing at least a plurality of windings as buried windings on one or more layer surfaces intermediate the opposite faces of the printed circuit board.

21. A multilayer printed circuit comprising:

(a) a multilayer circuit board having first and second faces,

(b) a transformer including:

(i) a magnetic core having:

(A) a plurality of core arms, each of which extends through a hole in the multilayer circuit board from the first face to the second face,

(B) a plurality of magnetic core elements, each extending along the first or second surface between ends of the core arms to complete a magnetic circuit comprised of the core arms and core elements to form a single, branchless, closed flux path,

(C) at least two series-connected windings forming a transformer primary printed on the multilayer circuit board, each in at least partially encircling relation to a core arm,

(D) at least two parallel-connected windings forming a transformer secondary printed on the multilayer circuit board, each in at least partially encircling relation to a core arm, and

(E) each core arm extending through the multilayer circuit board having at least one of the windings of the transformer primary or secondary wound thereon,

whereby each winding couples the identical flux in the core.

22. The multilayer printed circuit according to claim 21, further comprising transformer secondary output processing circuitry connected to the parallel-connected windings, each parallel-connected winding having substantially the same output processing circuitry connected thereto for similarly processing each parallel-connected winding output, the output processing circuitry being located between the parallel-connected windings and a point of interconnection thereof.

23. The multilayer printed circuit according to claim 22, wherein the point of interconnection is current additive.

24. The multilayer printed circuit according to claim 21, wherein at least one of the windings forming the transformer primary and at least one of the windings forming the transformer secondary are buried windings printed on a face of a layer of the multilayer circuit board interior of the first and second faces.

25. The multilayer printed circuit according to claim 21, wherein each of the connected in series windings forming the transformer primary has substantially the

same number of turns as each other of the connected in series windings forming the transformer primary.

26. The multilayer printed circuit according to claim 21, wherein each of the connected in parallel windings forming the transformer secondary has substantially the same number of turns as each other of the connected in parallel windings forming the transformer secondary.

27. The multilayer printed circuit according to claim 25, wherein each of the connected in parallel windings forming the transformer secondary has substantially the same number of turns as each other of the connected in parallel windings forming the transformer secondary.

28. The multilayer printed circuit according to claim 27, wherein on each of the core arms is wound at least one of the connected in series windings forming the transformer primary in closely coupled relation to at least one of the connected in parallel windings forming the transformer secondary.

29. The multilayer printed circuit according to claim 28, wherein the number of core arms is greater than two.

30. The multilayer printed circuit according to claim 29, wherein the core elements are plates overlying the first and second surfaces of the circuit board in flux communicating relation to each core arm.

31. A power magnetic component including:

(a) a multilayer circuit board having first and second exterior faces,

(b) a magnetic core comprising:

(i) a plurality of magnetic segments extending through the circuit board from one exterior face to the other exterior face,

(ii) at least two magnetic elements exterior of the circuit board,

each at one of the faces, and extending generally parallel to the faces of the board in flux conducting relation from one of the segments to another of the segments to form a single, closed, unbranched flux path, and

(c) at least one buried winding carried on a surface of a layer of the multilayer circuit board intermediate the exterior faces and at least partially encircling one of the magnetic segments.